
New Boraginaceae from Tropical America 4: Three New Species of *Cordia* from South America

James S. Miller

Missouri Botanical Garden, P. O. Box 299, St. Louis, Missouri 63166-0299, U.S.A.

ABSTRACT. Review of specimens newly collected for one of the International Cooperative Biodiversity Groups led to the recognition of three new species closely related to *Cordia trachyphylla* Martius, with which some specimens had previously been confused. All three are members of a group of species within *Cordia* sect. *Myxa* that are characterized by having a costate calyx. Three new species within this group are described, *Cordia hatschbachii*, *C. kingstoniana*, and *C. koemarae*, and a key is provided to assist in separation of the neotropical species of *Cordia* sect. *Myxa* with costate calyces.

Key words: Boraginaceae, *Cordia*, South America.

Cordia L. is the largest genus in the Boraginaceae with approximately 325 species that occur widely in tropical and subtropical parts of the world; the greatest number of species are restricted to the Neotropics. Most modern authors have recognized six sections in the genus *Cordia* (Taroda & Gibbs, 1986; Nowicke & Miller, 1990). Despite numerous suggestions that several of the morphologically diverse sections of the genus be recognized as separate genera (Nowicke & Ridgway, 1975), most modern authors have continued to treat the genus in a broad sense.

All six currently recognized sections of *Cordia* have all or most of their species in the New World. Sections *Gerascanthus* (Browne) G. Don, *Rhabdocalyx* A. DC., *Superbiflorae* Taroda, and *Varronia* (Browne) G. Don are all restricted to the New World. Species of *Cordia* sect. *Cordia* are mostly Caribbean, with an additional species in Somalia and one more widespread on beaches of the Indian and Pacific Oceans. By far the largest of the sections is *Cordia* sect. *Myxa* (Endlicher) DC., with close to 200 species, and it is the only section well represented in all regions of the tropics. The majority of the species occur in the Neotropics, but about 50 species occur in Africa and Madagascar, and perhaps 20 are known from tropical Asia. The section is difficult taxonomically and has not been treated in a comprehensive manner for the New World since de Candolle (1845), although species

have been covered in regional accounts (Johnston, 1930, 1935; Miller, 1988, 2001; Taroda & Gibbs, 1987). In particular, the South American taxa remain poorly known, and their morphological similarity makes it difficult to recognize coherent, manageable species groups. Many species in the section remain undescribed, particularly where the highest diversity occurs in northwestern South America. Recent novelties include the following three new species.

The three species described below all share a costate calyx and a decidedly acuminate leaf apex and are probably related to *Cordia trachyphylla* Martius. Although this name has been associated with specimens over a wide geographic range, recent review of available specimens indicates that Johnston's (1930) circumscription of a plant with ovate to elliptic-ovate leaves less than 16 cm long and 7 cm wide and with an acumen less than 1 cm long and restricted to Bahia was probably correct, and collections from other regions are best assigned to the following species.

***Cordia koemarae* J. S. Miller, sp. nov.** TYPE: Suriname. Sipaliwini: vicinity of the Ulemari River, 99 km upstream from its confluence with Litani River, low primary forest near river, elev. 150 m, 2°58'18"N, 54°33'14"W, 14 Apr. 1998, B. Hammel, S. Koemar & U. Raghoenandan 21493 (holotype, MO 04974007; isotypes, BBS, US). Figure 1.

Arbor ad 8 m alta, ramunculis sparse pilosis, trichomatis 2–2.5 mm longis. Folia persistentia; laminae anisophyllae, foliis majoribus ellipticis, 12–23.5 cm longis, 6–13 cm latis, minoribus orbicularis, ca. 8.5 cm longis, 7.5 cm latis, apice acuminato et caudato, acuminibus 1.5–2 cm longis, basi rotundata ad obtusam, margine integra, supra sericea, trichomatis 2.5–4 mm longis, appressis, pagina inferiore sericea ad pilosam, trichomatis 2–3 mm longis; petioli 4–7 mm longi. Inflorescentia terminalis vel axillaris, cymosa, 8–10 cm latis. Flores bisexuales; calyx tubularis, ca. 6 mm longus, 10-costatus; corolla alba, tubularis, 5-lobata; stamina 5, filis 8–10 mm longis, pubescentia ad insertionem.

Tree 8 m tall, the twigs sparsely but evenly pilose, the hairs 2–2.5 mm long, yellow-brown. Leaves persistent, dimorphic, larger leaf blades el-

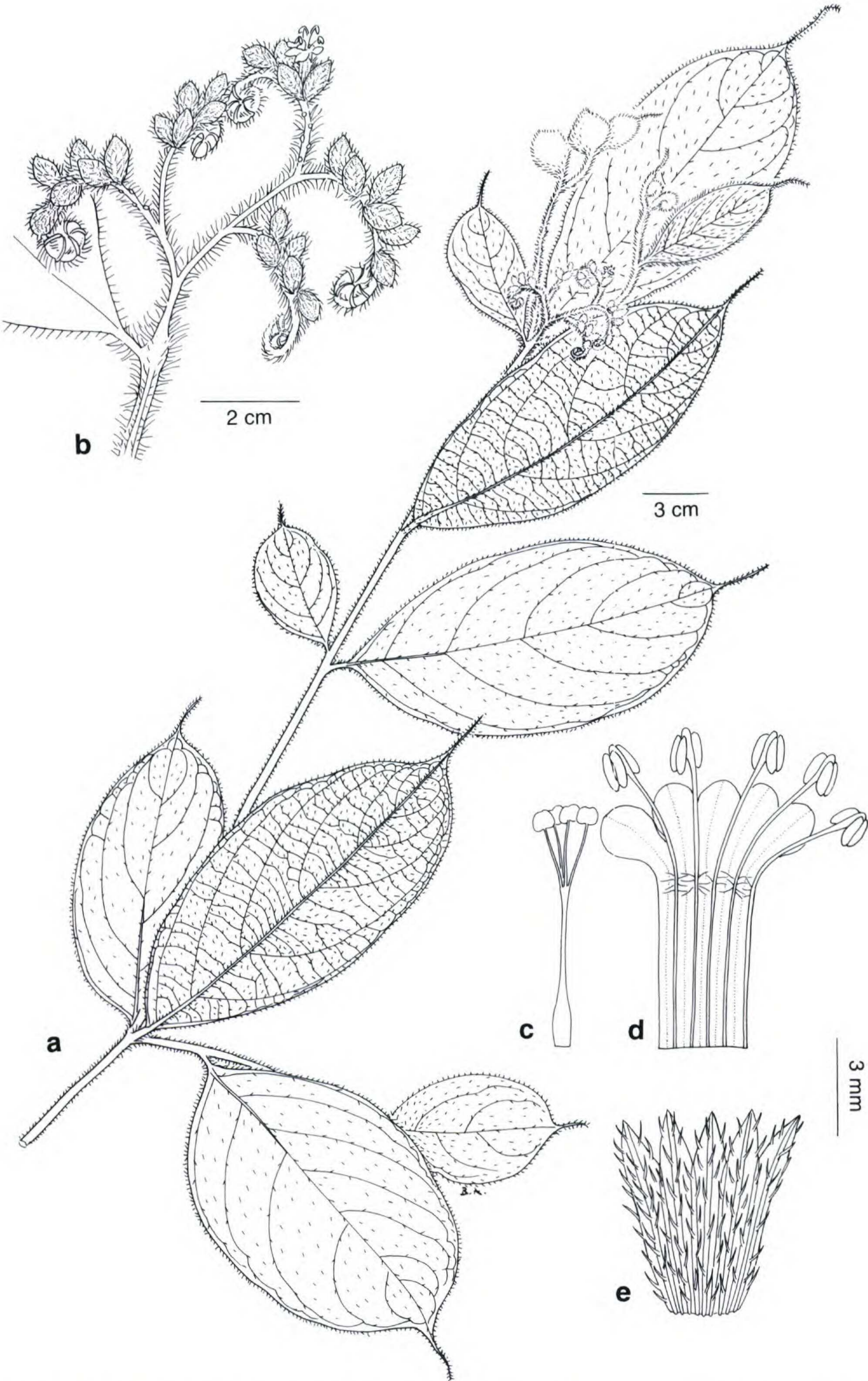


Figure 1. *Cordia koemarae* J. S. Miller. —a. Flowering branch. —b. Inflorescence. —c. Gynoecium. —d. Corolla opened to show insertion of stamens. —e. External surface of opened calyx. (All from Hammel et al. 21493, MO, holotype.)

liptic, 12–23.5 cm long, 6–13 cm wide, the apex abruptly acuminate, then caudate, the thin, hair-like acumen 1.5–2 cm long, the base rounded to obtuse, sometimes slightly unevenly so, the margin entire, the adaxial surface densely sericeous on young leaves, sparsely sericeous on mature leaves, the hairs tightly appressed, 2.5–4 mm long, the abaxial surface evenly sericeous to pilose, the hairs spreading, 2–3 mm long, the venation brochidodromous, the midrib slightly elevated, the secondary veins 6 or 7, connected by a series of nearly parallel tertiary veins, the dimorphic leaves borne opposed to larger leaves in branch axils, smaller, orbicular, ca. 8.5 cm long, 7.5 cm wide, petioles 4–7 mm long, canaliculate on the adaxial surface, pilose, the hairs ca. 3 mm long. Inflorescences terminal or borne in the axils of branches, cymose, 8–10 cm broad, the branches pilose, the hairs 2–3 mm long. Flowers bisexual; calyx narrowly tubular, ca. 6 mm long, 3 mm wide at the mouth, 10-costate, pilose, the hairs spreading, 1.5–2 mm long; corolla white, tubular with spreading lobes, ca. 8 mm long, the 5 lobes ovate, ca. 2 mm long, 1.5 mm wide; stamens 5, strongly exserted, the filaments 8–10 mm long, the upper 4–5 mm free, pubescent at the point of insertion, the anthers bilobed, a round gland present apically between the anther sacs; ovary ovoid, ca. 1 mm long, 0.5 mm wide, glabrous, the style ca. 3 mm long, the stigmas capitate. Fruits unknown.

Distribution. *Cordia koemarae* is known only from the type collection made in the southeastern corner of Suriname near the border with French Guiana.

Cordia koemarae is a distinctive species in its pilose indument, caudate leaf apex with a hair-like acumen about 2 cm long, and its 10-costate calyx. Many species of *Cordia* sect. *Myxa* have two opposing leaves borne from each branch axil, one of which is decidedly smaller and different in shape (frequently orbicular) from the other larger leaves. This appears to be the case with *C. koemarae*, although the duplicates of the single known collection show only a single smaller orbicular leaf. The flowers of the single known collection do have both stamens and an apparently normal gynoecium indicating that this species most probably has bisexual flowers, as opposed to the dioecy that characterizes the Central American species with costate calyces.

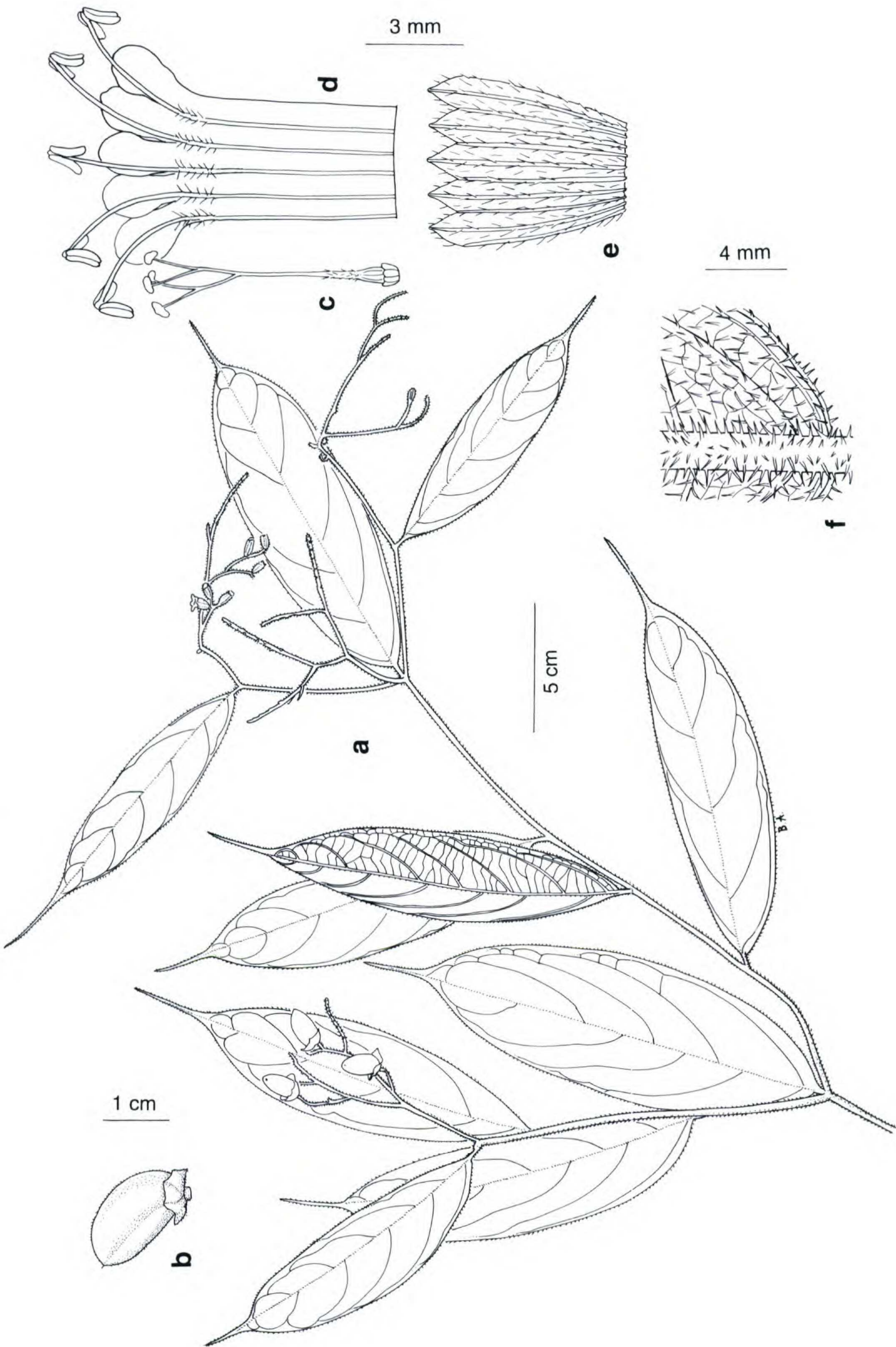
Cordia koemarae was identified from material collected in southeastern Suriname during review of specimens collected for the Suriname International Cooperative Biodiversity Group (ICBG). The

Suriname ICBG is a multi-institutional partnership with the three main goals of natural products drug discovery, economic development, and conservation. Fieldwork is conducted by members of the Missouri Botanical Garden and Conservation International in collaboration with staff of the National Herbarium of Suriname to collect bulk plant material for pharmaceutical evaluation and support biological inventory that contributes to conservation initiatives in Suriname. *Cordia koemarae* is named in honor of Sylva Koemar, who has helped to organize and conduct many of the field expeditions for the ICBG project and whose tireless efforts in the field have helped with the collection of many specimens that have added to our knowledge of the flora of Suriname, including the type of this new species.

Cordia kingstoniana J. S. Miller, sp. nov. TYPE: Peru. Loreto: Prov. Requena, Jenaro Herrera, elev. ca. 170 m, 4°50'S, 73°45'W, 3 July 1981, R. Vásquez, K. Young & N. Jaramillo 2143 (holotype, MO 3314002). Figure 2.

Frutex vel arbor parva ad 3(–12) m alta, ramunculis hirsutis ad strigillosos. Folia persistentia, homomorpha; lamina anguste elliptica ad leviter oblanceolatam vel lanceolatam, (9–)10.5–18(–23) cm longa, (2.5–)3–7(–10.5) cm lata, apice acuminato, acuminibus (0.8–)1.5–3 cm longis, basi rotundata ad acutam, margine integra, supra glabra, pagina inferiore strigosa; petioli 1–5(–10) mm longi. Inflorescentia terminalis et axillaris, 5–10(–15) cm latis. Flores bisexuales; calyx tubularis, 5–6.5 mm longus, leviter 10-costatus, sparse strigillosus ad hirsutum; corolla alba, tubularis, 5–7 mm longa, 5-lobata; stamina 5, filis 10–12 mm longis, pubescentia ad insertionem. Fructus drupaceus, albus, putamine inequilateraliter ellipsoideo, 1.3–1.8 cm longo, 0.8–1.1 cm lato.

Shrub or small tree to 3(–12) m tall, the stems hirsute or less commonly strigillose, the hairs 0.5–1 mm long. Leaves persistent, homomorphic; leaf blades narrowly elliptic to slightly oblanceolate or lanceolate, (9–)10.5–18(–23) cm long, (2.5–)3–7(–10.5) cm wide, the apex acuminate, the acumen (0.8–)1.5–3 cm long, the base rounded to acute, the margin entire, the adaxial surface glabrous, strigose on the midrib, the abaxial surface strigose, the venation brochidodromous, the midrib distinct and elevated on both surfaces, the secondary veins 6 to 8(–9); petioles 1–5(–10) mm long, flattened, rounded, or shallowly canaliculate on the adaxial surface, stiffly pubescent to hirsute, the hairs silaceous. Inflorescences terminal and in the axils of leaves and branches, 5–10(–15) cm broad, the branches hirsute, the hairs 0.5–1 mm long. Flowers bisexual; calyx tubular, 5–6.5 mm long, 2–3 mm wide at the mouth, lightly 10-costate, sparsely strigillose to hir-



sute, the hairs ca. 0.5 mm long, unevenly 3- to 5-lobed, the lobes widely triangular to ovate, 1–1.3 mm long; corolla white, tubular with reflexed lobes, 5–7 mm long, 5-lobed, the lobes obovate, 2–3 mm long, 1.5–1.8 mm wide; stamens 5, strongly exerted, the filaments 10–12 mm long, the upper 5–6 mm free, pubescent at the point of insertion, the anthers 1–1.5 mm long; ovary ovoid, 1–1.5 mm long, 0.6–0.8 mm wide, glabrous, the style 6–9 mm long, glabrous or with a few appressed hairs along the base, the stigmas capitate. Fruits drupaceous, white, subtended by the slightly expanded, cupulate calyx, the exocarp evidently strigillose to nearly glabrous, endocarp asymmetrically ellipsoid, 1.3–1.8 cm long, 0.8–1.1 cm broad.

Distribution. *Cordia kingstoniana* is widespread in western Amazonia in Peru, Ecuador, and adjacent Brazil, and it should be expected in southeastern Colombia.

This is a relatively widespread species known from a significant number of collections. This distinctive species is remarkably constant in appearance and can easily be recognized by its slender twigs and short-petioled narrowly elliptic leaves that are prominently acuminate. *Romoleroux & Foster 2015* and *Asunción 118* are unusual among collections of this new species in their large leaves. The name *Cordia trachyphylla* has been applied to specimens of *C. kingstoniana*, but leaves of the two species are quite distinct. *Cordia kingstoniana* has narrowly elliptic to slightly oblanceolate or lanceolate leaves that are close to parallel sided and have an acumen usually more than 1.5 cm long, while *C. trachyphylla* has more ovate leaves, definitely not parallel sided, and with an acumen less than 1 cm long.

This species is named in honor of David G. I. Kingston of Virginia Polytechnic Institute and State University who has contributed greatly to our knowledge of the medicinal value of plant-derived compounds, particularly those used to treat cancer. Prof. Kingston is the group leader and coordinates the ICBG project.

Additional specimens examined. BRAZIL. **Amazonas:** São Paulo de Olivença, *Mori et al. 9182* (MO). **Pará:** Mun. de Itaituba, estrada Santarém–Cuiabá, BR 163, Km 1229, *Silva 385* (MO). **Rondônia:** vicinity of Santa Barbara, 15 km E of Km 117, *Prance & Ramos 7181* (MO); Porto Velho, Represa Samuel, forest along PR-3 road, ca. 10 km SE of dam, 8°49'S, 63°24'W, *Thomas et al. 5133*

(MO). ECUADOR. **Napo:** Orellana, Parque Nacional Yasuní, carretera y oleoducto de Maxus en construcción, Km 54–58, elev. 250 m, 0°48'S, 76°30'W, *Aulestia & Andi 714* (MO); Estación Científica Yasuní, Parcela de 50 ha, elev. 200–300 m, 0°38'S, 76°30'W, *Romoleroux & Grefa 1835* (MO), *2015* (MO). PERU. **Amazonas:** Monte Virgin, 1 km de bajo de La Poza, Río Santiago, elev. 180 m, *Asunción 118* (MO); Monte Virgin, 2 km abajo de la comunidad de Caterpiza, trocha de Mitayar, banda oeste de la Quebrada Caterpiza, Río Santiago, *Huashikat 610* (MO). **Loreto:** Prov. Maynas, Caserio de Huanta, Río Orosa, a 5 minutos de la boca, margen izquierda una hora de camino, monte alto, elev. 120 m, *Díaz et al. 476* (MO); Prov. Maynas, Yanamono, Explorama Tourist Camp on Río Amazonas between Indiana and mouth of Río Napo, elev. 120 m, 3°28'S, 72°48'W, *Gentry et al. 29129* (MO-2); Prov. Alto Amazonas, Andoas, Río Pastaza near Ecuador border, elev. 210 m, 2°48'S, 76°28'W, *Gentry et al. 29783* (MO); Prov. Maynas, Iquitos, Estación Biológica Allpahuayo, elev. 130 m, 3°53'S, 73°25'W, *Jaramillo & Marcos 709* (MO); Prov. Maynas, Distrito Pebas, Río Ampiyacu, cerca a estación IMARPE, 1 km antes de Quistocha, *Revilla 936* (MO); Prov. Maynas, Distrito Iquitos, Río Nanay, carretera del Caserio de Lupuna to Santa Clotilde, in front of Bella Vista, *Rimachi 1786* (MO); Prov. Maynas, Distrito Iquitos, Río Nanay near mouth, carretera de Picuruyacu, trocha del fundo “Monte Azul”, elev. ca. 160 m, *Rimachi 6633* (MO); Prov. Maynas, Distrito Iquitos, carretera del caserio de Puerto Almendras, monte alto, arcilloso, cerca al terreno de la UNAP, elev. ca. 140 m, *Rimachi 6948* (MO); Prov. Maynas, Puerto Almendras, elev. 122 m, 3°48'S, 73°25'W, *Vásquez & Jaramillo 4238* (MO); Prov. Maynas, Indiana, Explorama Reserve, elev. 108 m, 3°30'S, 73°05'W, *Vásquez et al. 13449* (MO); Prov. Maynas, Iquitos, Allpahuayo, Estación Experimental del Instituto de Investigaciones de la Amazonia Peruana (IIAP), *Vásquez et al. 13869* (MO), *Vásquez & Jaramillo 14066* (MO), *Vásquez et al. 16239* (MO), *Vásquez 16713* (MO), *Vásquez et al. 23544* (MO).

***Cordia hatschbachii* J. S. Miller, sp. nov.** TYPE: Brazil. Espírito Santo: Mun. Linhares, Reserva Flora da Sooretama, Rod. BR-101, 8 Apr. 1984, *G. Hatschbach 47742* (holotype, MO 3648229; isotypes, MBM, MO). Figure 3.

Frutex 2 m alta, ramunculis pubescentibus. Folia persistentia; lamina oblanceolata ad anguste ellipticam, 14.5–30 cm longa, 3.8–6.3 cm lata, apice acuminato, basi attenuata ad acutam, margine integra et leviter revoluta, supra scabra, pagina inferiore pubescenti; petioli 4–6 mm longi. Inflorescentia terminalis, cymosa, 6–9.5 cm lata. Flores bisexuales; calyx tubularis, 5–5.5 mm longus, 10-costatus; corolla alba, tubularis, 6.5–8 mm longa, 5-lobata; stamina 5, filis ca. 8.5 mm longis, pubescentia ad insertionem.

Shrub 2 m tall, the stems stiffly pubescent, the hairs spreading, 0.5–1 mm long. Leaves persistent;

←

Figure 2. *Cordia kingstoniana* J. S. Miller. —a. Flowering branch. —b. Fruit asymmetrical in persistent calyx. —c. Gynoecium. —d. Corolla opened to show insertion of stamens. —e. External surface of opened calyx. —f. Lower surface of leaf base. (All from *Vásquez et al. 2143*, MO, holotype.)



Figure 3. *Cordia hatschbachii* J. S. Miller. —a. Flowering branch. —b. External surface of opened calyx. —c. Gynoecium. —d. Corolla opened to show insertion of stamens. (All from *Hatschbach 47742*, MO, holotype.)

leaf blade oblanceolate to narrowly elliptic, the broadest point above the middle, 14.5–30 cm long, 3.8–6.3 cm wide, the apex acuminate, the base attenuate to acute, the margin entire and slightly revolute, the adaxial surface scabrous, very rough to the touch, coarsely and stiffly pubescent along the primary and secondary veins, the abaxial surface stiffly pubescent, densely so on the primary and secondary veins, venation brochidodromous, the midrib slightly elevated above, distinct and terete below, coarsely pubescent on both surfaces, the secondary veins 8 to 12; petioles 4–6 mm long, canaliculate above, coarsely pubescent. Inflorescences terminal, cymose, 6–9.5 cm broad, coarsely pubescent, the peduncles 0.8–5.5 cm long. Flowers bisexual; calyx tubular, 5–5.5 mm long, 1.5–2 mm wide at the mouth, 10-costate, densely pubescent, 5-lobed, the lobes triangular, ca. 1 mm long; corolla white, tubular, 6.5–8 mm long, 5-lobed, the lobes spreading to reflexed, ovate, ca. 2.5 mm long, 1.8 mm wide; stamens 5, the filaments ca. 8.5 mm long, the upper 4 mm free, pubescent at the point of insertion, the anthers ca. 1.5 mm long; ovary ovoid, ca. 1.5 mm long, 1 mm wide, glabrous, the style ca. 5 mm long, the stigmas capitate. Young fruits drupaceous, subtended by the calyx, the exocarp minutely strigillose, mature fruits unknown.

Distribution. *Cordia hatschbachii* is known only from the type collection from Atlantic coastal forests in Espírito Santo.

This species is quite distinctive in its long (14.5–30 cm) narrowly oblanceolate leaf blades that are somewhat clustered near the ends of branches. This species is named in honor of Gert Hatschbach, from the Museu Botânico Municipal in Curitiba, Brazil, whose collections and research have contributed so much to our knowledge of the forests of coastal Brazil. The type collection is one of many invaluable collections that he has made documenting the diversity and conservation importance of this highly threatened region so rich in endemic species.

Cordia sect. *Myxa* is a large, diverse group, and recognition of groups of related species within the section has proven difficult. One character that is very distinctive in the section, is easily visible on specimens, and occurs in only a limited number of species is the presence of a costate calyx. This character facilitates species recognition but most probably does not circumscribe a monophyletic group. The four species with costate calyces in Central America (*C. cordiformis* I. M. Johnston, *C. diversifolia* A. DC., *C. salvadorensis* Standley, and *C. skutchii* I. M. Johnston) are probably closely related, as they also share serrate leaf margins and

dioecy. However, the South American *C. trachyphylla*, *C. trichoclada* DC., *C. chamissoniana* Don, *C. gardneri* I. M. Johnston, *C. sipapoi* Gaviria, *C. decipiens* I. M. Johnston, and the three new species described here are quite diverse morphologically, may not be a monophyletic group, and are probably a different lineage from the species with costate calyces in Central America. Yet costate calyces is an easily observable character useful for recognition of species, so the key presented below is for purposes of identification and is not meant to convey any sense of relationship.

KEY TO THE NEOTROPICAL SPECIES OF *CORDIA* SECT. *MYXA* WITH COSTATE CALYCES

- 1a. Leaf margins serrate to minutely denticulate; Central America and Mexico.
 - 2a. Leaf base acute, obtuse, or rounded.
 - 3a. Leaves at least 3 times as long as wide; stigma lobes clavate; calyx 3.7–6.5 mm long.
 - 4a. Upper leaf surface evenly strigose; corolla 7.5–10.5 mm long; southern Mexico to Panama *C. diversifolia*
 - 4b. Upper leaf surface glabrous to scabrous; corolla 5.8–6.5 mm long; Guatemala *C. skutchii*
 - 3b. Leaves usually less than 3 times as long as wide; stigma lobes filiform; calyx 3–4 mm long; Mexico to Nicaragua *C. salvadorensis*
 - 2b. Leaf base cordate; Mexico to Guatemala *C. cordiformis*
- 1b. Leaf margins entire; South America.
 - 5a. Leaves greater than 15 cm wide.
 - 6a. Leaves bullate; southeastern Brazil *C. trichoclada*
 - 6b. Leaves not bullate; Brazil and Peru *C. chamissoniana*
 - 5b. Leaves less than 13 cm wide.
 - 7a. Leaves elliptic or elliptic-ovate, ca. twice as long as wide.
 - 8a. Stems and leaves pilose, the hairs more than 1 mm long.
 - 9a. Leaf apex caudate; ovary glabrous; Suriname *C. koemarae*
 - 9b. Leaf apex acute to attenuate; southeastern Brazil *C. gardneri*
 - 8b. Stems and leaves various, the hairs less than 1 mm long.
 - 10a. Ovary glabrous.
 - 11a. Leaf base acute; southeastern Brazil . . *C. trachyphylla*
 - 11b. Leaf base obtuse to rounded; Venezuela *C. sipapoi*
 - 10b. Ovary pubescent; northwestern Brazil . . . *C. decipiens*

- 7b. Leaves lanceolate to narrowly elliptic or oblanceolate, at least 3 times as long as wide.
- 12a. Hairs on stems erect; leaf base rounded to acute; Brazil, Ecuador and Peru . . . *C. kingstoniana*
- 12b. Hairs on stems spreading; leaf base attenuate to acute; south-eastern Brazil . . . *C. hatschbachii*

Acknowledgments. Financial support for the ICBG project was provided by the National Institutes of Health, the National Science Foundation, and the U.S. Agency for International Development, under Grant No. U01 TW/CA-00313. Joshua Rosenthal, of the Fogarty International Center, NIH, and James Rodman, NSF, have provided tremendous support and encouragement for the ICBG project. I also thank Barbara Alongi for the illustrations.

Literature Cited

- Candolle, A.P. de. 1845. Boraginaceae. *In*: Prodrromus Systematis Naturalis Regni Vegetabilis 9: 466–501.
- Johnston, I. M. 1930. Studies in the Boraginaceae VIII. Observations on the species of *Cordia* and *Tournefortia* known from Brazil, Paraguay, Uruguay, and Argentina. *Contr. Gray Herb.* 92: 3–89.
- . 1935. Studies in the Boraginaceae X. The Boraginaceae of northeastern South America. *J. Arnold Arbor.* 16: 1–64.
- Miller, J. S. 1988. A revised treatment of Boraginaceae for Panama. *Ann. Missouri Bot. Gard.* 75: 456–521.
- . 2001. Boraginaceae. *In*: W. D. Stevens, C. Ulloa U., A. Pool & O. M. Montiel (editors), *Flora de Nicaragua*. Monogr. Syst. Bot. Missouri Bot. Gard. 85. 1: 435–455.
- Nowicke, J. W. & J. E. Ridgway. 1975. Pollen studies in the genus *Cordia* (Boraginaceae). *Amer. J. Bot.* 60: 584–591.
- & J. S. Miller. 1990. Pollen morphology of the Cordioideae (Boraginaceae): *Auxemma*, *Cordia*, and *Patagonula*. *Pl. Syst. Evol.* [Suppl. 5]: 103–121.
- Taroda, N. & P. E. Gibbs. 1986. Studies on the genus *Cordia* L. (Boraginaceae) in Brazil. 1. A new infrageneric classification and conspectus. *Revista Brasil. Bot.* 9: 31–42.
- & ———. 1987. Studies in the genus *Cordia* L. (Boraginaceae) in Brazil. 2. An outline taxonomic revision of subgenus *Myxa* Taroda. *Hoehnea* 14: 31–52.